Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 43 (2012) 226 – 231

Procedia
Social and Behavioral Sciences

8th International Conference on Traffic and Transportation Studies
Changsha, China, August 1–3, 2012

An Investigation on the Manual Traffic Count Accuracy

Pengjun Zheng[a,*], McDonad Mike[a,b]

[a] *Faculty of Maritime and Transportation, Ningbo University, Ningbo, China*
[b] *Transportation Research Group, University of Southampton, Southampton, UK*

Abstract

The research reported in this paper is an empirical observation and quantification of errors in manual traffic counting. Despite the extensive use of manual count data in the national traffic census and assessment, the accuracy of manual counting appears not to have been well investigated and reported. The issue has been investigated and reported in this paper. It is believed that findings from this research could be very useful for traffic assessment using manual count as ground-truth.

Keywords: manual count; traffic information quality; traffic survey

1. Introduction

Traffic counting determines the number and classifications of vehicles at specific locations and times. There are two methods for counting traffic: manual and automatic. Manual counting usually refer to the practice of counting classified traffic in a 'manual fashion'. Some examples of traffic counting include vehicle counts at intersections, estimation of average daily traffic and annual average daily traffic (Adebisi, 1987; Baker, et al., 1982,Findley, et al., 2011).

Manual counting and classification can be carried out on the site or alternatively from video recordings. Counting and classification are simply based on visual examination and judgments by individual observers. The data is usually recorded using tally sheets or mechanical counters. After data have been

* Corresponding author.
E-mail address: pjzheng@gmail.com

doi:10.1016/j.sbspro.2012.04.095

collected for an interval (e.g. 1 min), totals are calculated and registered on a data sheet which can be input into computer later (Schumann, 2001; Wylie, 2010; Jalihal, et al., 2005).

It is usually taken for granted that errors in manual counts are small and can be ignored. (MNDOT, 2002, Zhao, et al., 1998) However, the impacts of manual count errors are very application dependent. Under certain circumstances, they could be sensitive to the errors in manual counts. Empirical investigations may be necessary in order to determine whether errors in manual counts can affect traffic assessment results. For this purpose, some test manual count data was collected. Statistical analysis was applied to the data and manual count errors were quantified. The effects of manual count errors on the results of a traffic assessment schemes were also investigated to exemplify the effects of manual counting errors.

2. Data collection and reduction

Manual counts data refers to the traffic counts for different classes of vehicles derived in a manual fashion. There are basically two factors which may affect the quality of manual counts, the quality of video recording and quality of manual reduction. Quality of video recording refers to the quality of image in terms of distortion, view angle, lighting etc. Cameras should be positioned where there is a clear view of traffic. Quality of manual reduction is mainly associated with efforts made in the manual data reduction, e.g. speed of reduction, counting aids (e.g. mechanical counter, computer program) and experience of inspector.

This investigation was based on manual counts reduced by staff working at Transportation Research Group (TRG) of University of Southampton, derived from video recordings purposely collected by the TRG. The raw data were taken from video recordings of a video camera survey at two sites near Southampton. The first site was at Junction 3 on the M27, westbound, three cameras were used, one for upstream main line traffic, one for downstream mainline traffic and one for diverge traffic. The other site was at Junction 12 on the M3, Southbound, two cameras were used, one for upstream main line traffic, one for downstream mainline traffic and the associated diverge traffic. At these sites, the motorway mainline had three lanes and the diverges had two lanes. Traffic was generally busy. Cameras were set on the bridges and positioned in such a way that vehicles were not obscured from each other. A typical camera view of traffic is shown in Fig. 1. Traffic was videotaped for a period of 10 hours between 7:00 am and 5:00pm, covering peak and off-peak periods.

Fig. 1. View of Traffic at M27 Site

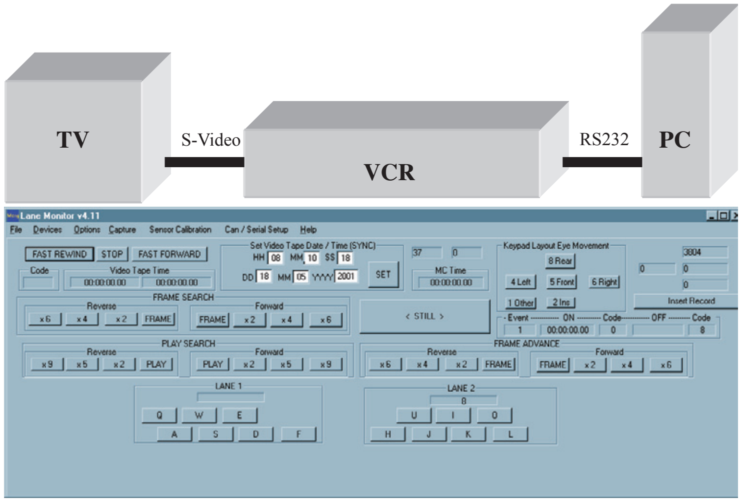

Fig. 2. Architecture and User Interface of Computer Controlled VCR logger

An instrument aid was used in the reduction of traffic counts from video recording. The instrument is a computer controlled VCR as depicted in Fig. 2. The playback speed of the VCR can be controlled through a computer user interface, from 1 frame per second to 9 times normal play speed. During playback, all key strokes with time stamp can be registered and saved into a text file for each data reduction session. Operators can assign different alphabets to represent different classes of vehicles so that classified counts with time stamp can be registered using this instrument.

The classification was based on the judgment by the inspector in accordance with predefined vehicle lengths:

- ‘Short Vehicle’ Less than 5.2 meters in length
- ‘Long Vehicle’ Equal to or More than 5.2 meters in length

Three subjects were assigned to carry out traffic counts from video recording. Subjects played the video at a speed suitable to him/her, and pushed the relevant key (e.g., L for long vehicle and S for short vehicle) when a vehicle passed on the loop. Typo errors can be avoided in this way as all records were not taken manually.

As traffic was counted manually by three different subjects at two sites, the TRG data consisted of 6 sets of manual counts, each containing about 150 1-min counts. Three paired comparisons can be made between manual counts derived by three individuals. Based on videos at two sites, 6 paired comparisons can be made in total.

3. Manual count errors

Traffic counting determines the number and classifications of vehicles at specific locations and times. There are two methods for counting traffic: manual and automatic. Manual counting usually refer to the practice of counting classified traffic in a ‘manual fashion’. Some examples of traffic counting include vehicle counts at intersections, estimation of average daily traffic and annual average daily traffic.

Vehicles are counted and classified during the manual counting process. Tow types of errors may occur:

Counting Errors: can be defined as the difference between the number of vehicles counted and the true number of vehicles in the same time interval.

$$ecount=(C_m-C_t) \tag{1}$$

where C_m is number of vehicles counted manually, and C_t is the actual number of vehicles in the same time interval.

Classification Errors: can be defined as the number of vehicles which have been classified in wrong classes. In practice, however, this cannot easily be measured. For example, an error of -1 in the count of short vehicles may be a result that one short vehicle has been classified as a long vehicle, or that one short vehicle has been missed in the counting process. There is no way to verify that this is a miss or a mis-classification.

However, a mis-classification of vehicle classes from i to j will always lead to an error of one vehicle in classified counts both for i and j classes, but will not result in any error in the total counts, i.e. classification errors are reflected in the errors for classified counts but not in the total count errors. Therefore, more practically, classification error can be defined as the difference between the sum of the absolute classified errors and the absolute total error:

$$e^{class} = \sum_i \left| e_i^{count} \right| - \left| e^{count} \right| \tag{2}$$

where i is the classes of vehicles. In this way, mis-classification of one vehicle will result in a classification error of 2 vehicles.

As there is no absolutely accurate ground truth data, manual count errors cannot be evaluated against truth directly. Alternatively, errors can be evaluated indirectly based on a paired comparison, e.g. manual counts derived by two different subjects are compared to identify the differences.

The errors in the manual counts can be estimated from the calculated differences. The relationship can be expressed as:

$$d = (e_a - e_b) \sim N(\mu_a - \mu_b, \sqrt{\sigma_a^{\ 2} + \sigma_b^{\ 2}}) \tag{3}$$

where d is the differences, e_a and e_b are errors in manual counts derived by subject a and b respectively, $e_a \sim N(\mu_a, \sigma_a)$, and $e_b \sim N(\mu_b, \sigma_b)$. N denotes a Normal distribution.

It is clear that if manual counts derived by different subjects are of similar accuracy ($\mu_a \approx \mu_b, \sigma_a \approx \sigma_b \approx \sigma$), then Eq. (3) can be approximated by:

$$d \sim N(\mu_a - \mu_b, \sqrt{\sigma_a^{\ 2} + \sigma_b^{\ 2}}) \approx N(0, \sqrt{2}\sigma) \tag{4}$$

That is, the standard deviation of paired manual count differences is about 1.4 times of that for manual count errors.

4. Results

The manual count errors are analysed based on an aggregation level of 5 minutes. This is because both the classified and unclassified errors in the assessment are usually calculated from errors in 5-min counts.

Differences are calculated for ‘Long’ and ‘Short’ classes of vehicles, and the sum of them is the total differences. Percentage differences are all calculated against total number of vehicles so that they are proportional to absolute differences. Their distribution parameters are shown in Fig. 3, where the length of ‘box’ denotes mean of differences and the length of ‘whisker’ denotes standard deviation.

This investigation was based on manual counts reduced by staff working at Transportation Research Group (TRG) of University of Southampton, derived from video recordings purposely collected by the TRG. The raw data were taken from video recordings of a video camera survey at two sites near Southampton. The first site was at Junction 3 on the M27, westbound, three cameras were used, one for upstream main line traffic, one for downstream mainline traffic and one for diverge traffic. The other site was at Junction 12 on the M3, Southbound, two cameras were used, one for upstream main line traffic, one for downstream mainline traffic and the associated diverge traffic. At these sites, the motorway

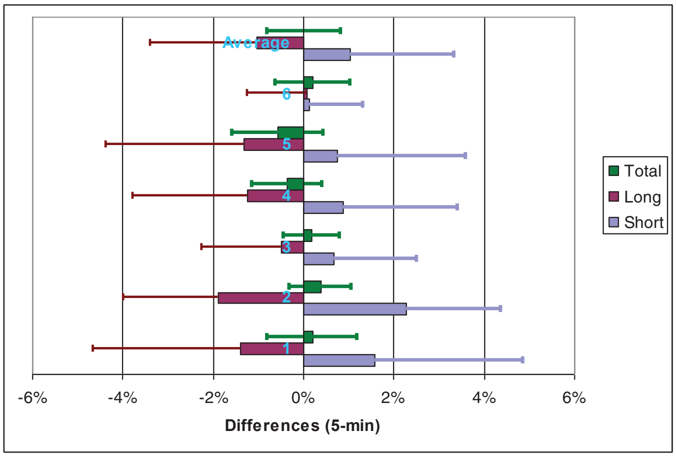

Fig. 3. Paired differences between counts of different subjects

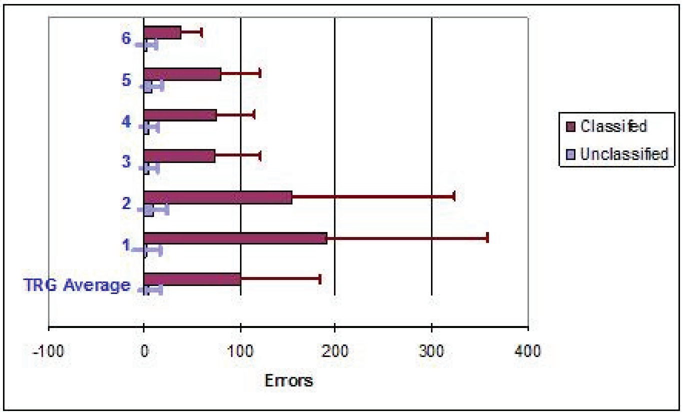

Fig. 4. Absolute unclassified and classified errors caused by differences in manual counts between two subjects

mainline had three lanes and the diverges had two lanes. Traffic was generally busy. Cameras were set on the bridges and positioned in such a way that vehicles were not obscured from each other. A typical camera view of traffic is shown in Fig. 1. Traffic was videotaped for a period of 10 hours between 7:00 am and 5:00pm, covering peak and off-peak periods.

It can be observed that the total differences are small, the average differences are 0.01%±0.82% (equivalent errors: 0.01%±0.58%). That is, the total number of vehicles counted by two different subjects is very close, i.e. the counting errors are small. However, it can be clearly seen that large discrepancies exist between a pair of subjects regarding the classification; this has been revealed in the big differences both for 'Long' and 'Short' counts. It is also clear that under-counting in one class of vehicles has always been accompanied by over-counting in the other class of vehicles, an indication that classification errors are relatively large. The average classification differences are 3.71%±3.28% (equivalent errors: 3.71%±2.32%).

The equivalent absolute errors (in vehicle per hour) are shown in Figures 4. The unclassified errors are small, with absolute errors mainly within ±20 and percentage errors within ±1%. However, the classified errors are significant, with the majority of absolute errors over 100 vph and percentage errors over 5%, i.e. manual count differences could lead to large differences in the calculated errors for assessment.

It is clear that manual count errors will mainly affect the assessment of classified section flows, but not the unclassified ones. This seems reasonable as the subjective judgment of classification is much more difficult than counting the number of vehicles.

5. Conclusions

Despite the extensive use of manual count data in the national traffic census and assessment, the accuracy of manual counting appears not to have been well investigated and reported. The issue has been investigated and reported in this paper.

The investigation was based on the manual counts derived from video recordings. Regarding the errors in the 5-min manual counts:

- Counting errors are small, usually less than 1%
- Classification errors are significant, with an average between 4-5%.

The main errors are classification errors, a reflection of difficulties in judging vehicles by a length threshold of 5.2 m from video recordings.

The effect of manual count errors on the compliance score is complex. It has been shown that classification errors are dominated by the manual count errors and the assessment of classified flows is likely to be affected. The impacts of manual count errors on the assessment results will be most significant if the accuracy of the loop is just at the verge of the contractual assessment requirements.

Acknowledgements

The research was supported in part by Disciplinary Project of Ningbo under grant, and Mike McDonald was supported in part by Pao Yukong Professorship of Ningbo University.

References

Adebisi, O. 1987. “Improving Manual Counts on Turning Traffic Volumes at Road Junctions.” Journal of Transportation Engineering-ASCE, Vol. 113, No. 3, 256-267.

Baker, H. and Wallace, D. 1982. ‘Software Technology Gets Rid of the TIC in Manual Traffic,’ ITE Journal – Institute of Transportation Engineers, Vol. 52, No. 4, 30-31.

MNDOT and SRF Consulting Group, 2002. “NIT Phase II: Evaluation of Non-Intrusive Technologies for Traffic Detection”, Final Report.

Schumann, R. 2001. “Summary Of Transportation Operations Data Issues”, PBS&J.

Zhao, M., Garrick, N. W.; Achenie, L. E.K. 1998. “Data reconciliation-based traffic count analysis system”. Transportation Research Record, 1625, pp 12-17

Wylie, M. 2010. “Automating the collection of turning count data at signalised intersections in Southampton”, Traffic Engineering and Control, Vol. 51, No. 11, pp 429-431.

Findley, D. J. 2011. “Comparison of mobile and manual data collection for roadway components”, Transportation Research Part C, vol 19, No. 3, pp. 521-540.

Jalihal, S.A., Reddy, T.S., Nataraju, J. 2005, “Evaluation of automatic traffic counters under mixed traffic conditions”, Journal of the Institution of Engineers (India): Civil Engineering Division, Vol. 86, pp 96-102.